US011810743B2

(12) **United States Patent**
Hazawa et al.

(10) **Patent No.: US 11,810,743 B2**
(45) **Date of Patent: Nov. 7, 2023**

(54) **MECHANICAL LATCHING DEVICE OF ELECTROMAGNETIC CONTACTOR**

(71) Applicant: **FUJI ELECTRIC FA COMPONENTS & SYSTEMS CO., LTD.**, Konosu (JP)

(72) Inventors: **Koumei Hazawa**, Kounosu (JP); **Ryotaro Ninagawa**, Kounosu (JP)

(73) Assignee: **FUJI ELECTRIC FA COMPONENTS & SYSTEMS CO., LTD.**, Saitama (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/826,383**

(22) Filed: **May 27, 2022**

(65) **Prior Publication Data**

US 2023/0005690 A1 Jan. 5, 2023

(30) **Foreign Application Priority Data**

Jul. 5, 2021 (JP) 2021-111552

(51) **Int. Cl.**
H01H 50/32 (2006.01)
H01H 50/64 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01H 50/32*** (2013.01); ***H01H 50/643*** (2013.01); ***H01H 51/10*** (2013.01); *H01H 50/02* (2013.01)

(58) **Field of Classification Search**
CPC H01H 51/10; H01H 50/32
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,455,763 A * 5/1923 Werner H01H 50/32 335/173
2,932,705 A * 4/1960 Nicolaus H01H 51/10 335/189

(Continued)

FOREIGN PATENT DOCUMENTS

DE 19631533 A1 1/1998
JP 2000251601 A 9/2000

OTHER PUBLICATIONS

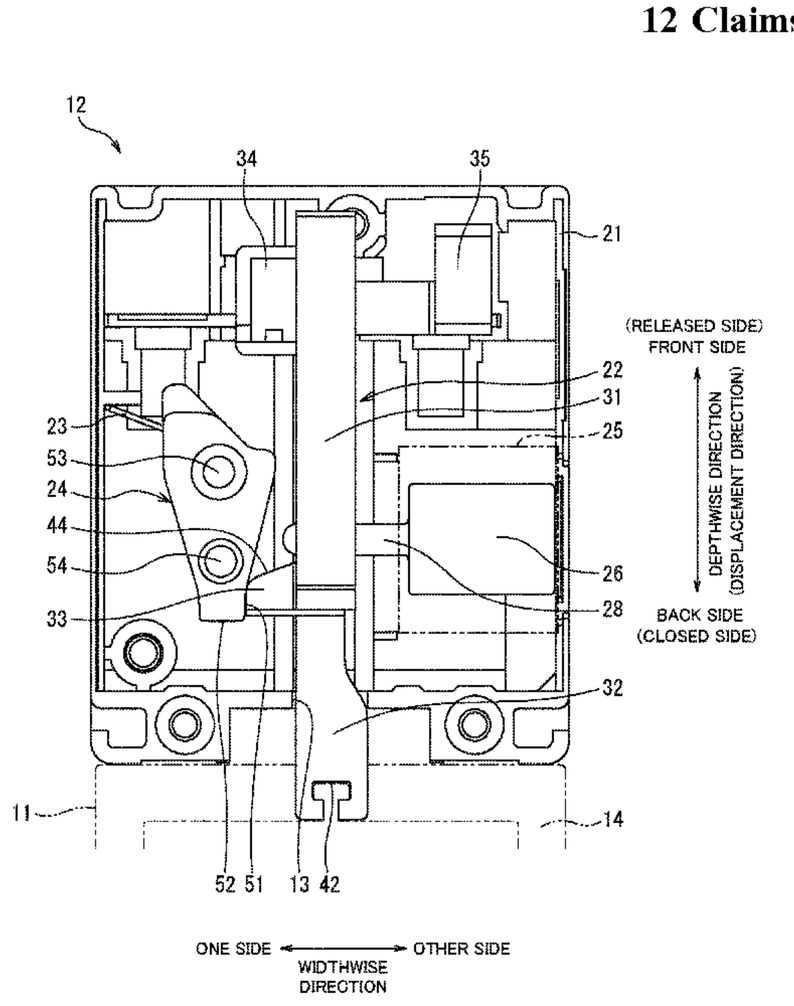
Extended European Search Report dated Nov. 21, 2022 in related European Patent Application No. 22175004.5 (8 pages) (in English).

Primary Examiner — Alexander Talpalatski

(57) **ABSTRACT**

A mechanical latching device of an electromagnetic contactor eliminates a need to adjust a gap between portions mechanically preventing returning of a latch support. A latch support includes a protrusion protruding laterally and formed with a latch surface facing a released side. A rotating member has one end side rotatably supported and the other end side biased toward the protrusion. When the latch support is on the released side, an outer peripheral surface of the other end side contacts with a tip of the protrusion to allow the latch support to be displaced to a closed side. When the latch support is on the closed side, the other end side rotates according to a position of the latch support in a displacement direction, and a tip surface faces the latch surface to mechanically prevent the latch support from returning to the released side at plural positions along the displacement direction.

12 Claims, 7 Drawing Sheets



(51) **Int. Cl.**
H01H 51/10 (2006.01)
H01H 50/02 (2006.01)

(58) **Field of Classification Search**
USPC 335/167
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,882,435	A *	5/1975	Grass	H01H 51/10 335/167
4,710,739	A *	12/1987	Heyne	H01H 71/1054 335/170
5,300,906	A *	4/1994	Blanchard	H01H 71/32 335/167
6,922,121	B2 *	7/2005	Kim	H01F 7/124 335/253

* cited by examiner

FIG. 1

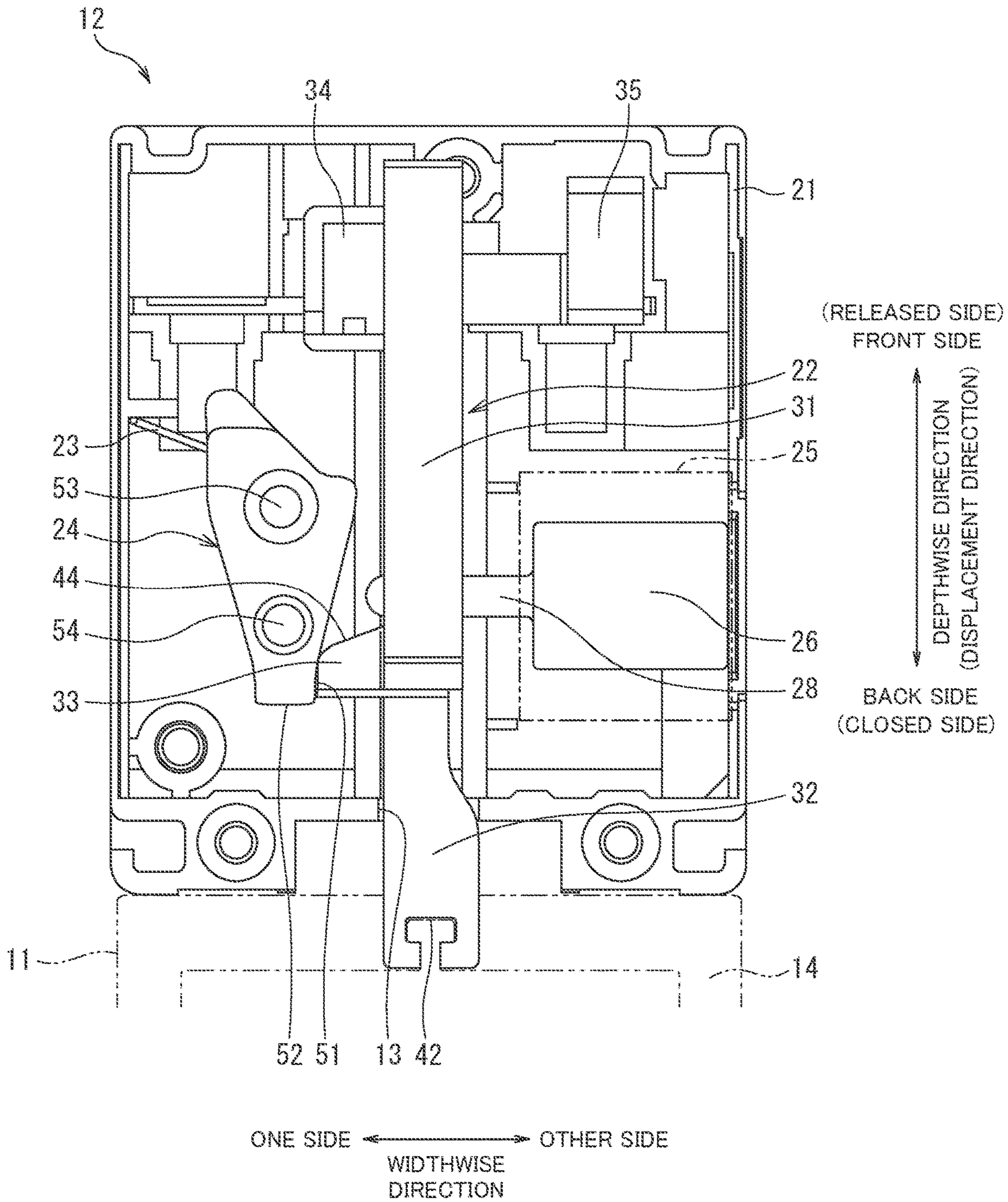

12
34
35
21
22
31
25
23
53
24
44
54
26
28
33
32
11
14
52
51
13
42
(RELEASED SIDE)
FRONT SIDE
DEPTHWISE DIRECTION
(DISPLACEMENT DIRECTION)
BACK SIDE
(CLOSED SIDE)
ONE SIDE
OTHER SIDE
WIDTHWISE
DIRECTION

FIG. 2

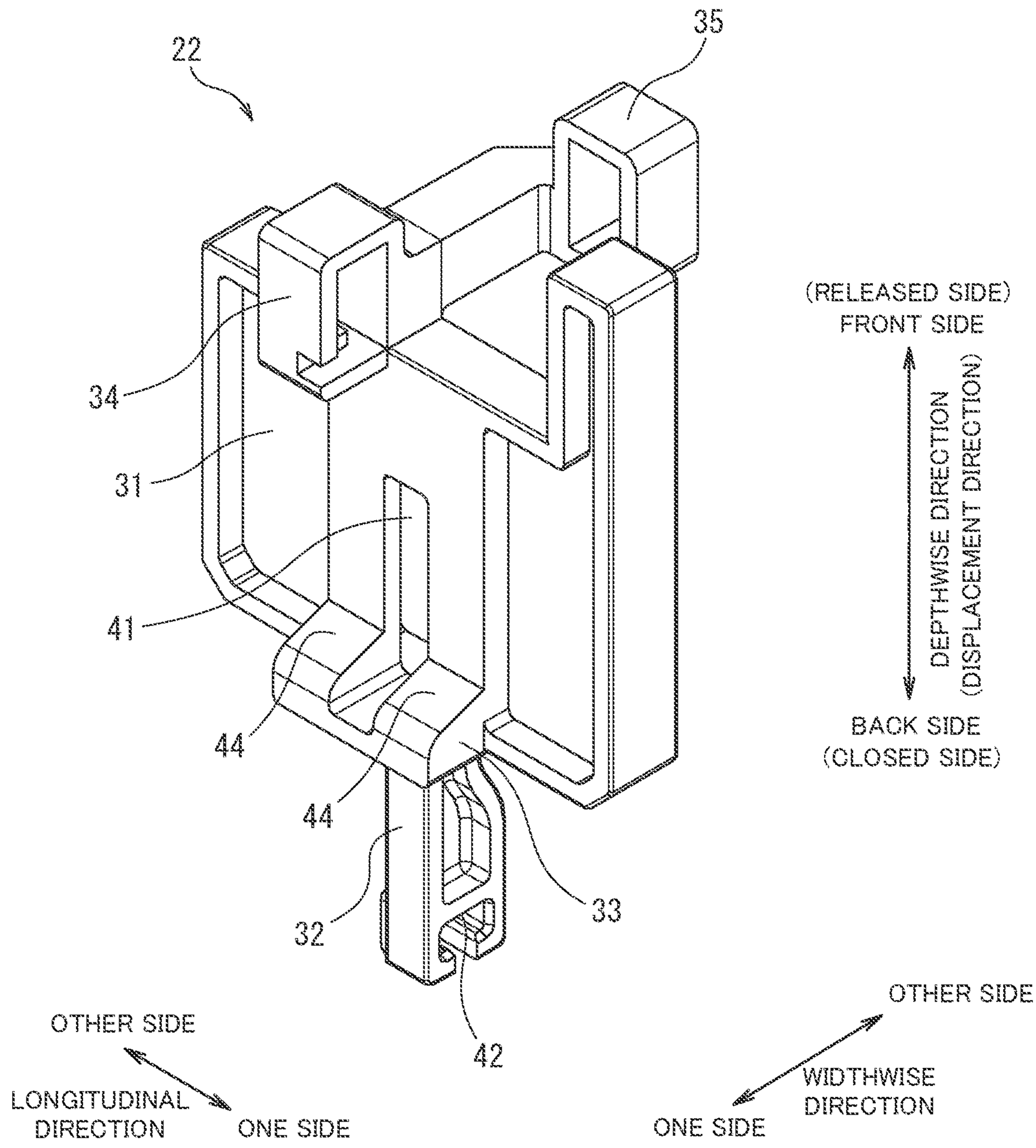

22
35
34
31
41
44
44
32
33
42
(RELEASED SIDE)
FRONT SIDE
DEPTHWISE DIRECTION
(DISPLACEMENT DIRECTION)
BACK SIDE
(CLOSED SIDE)
OTHER SIDE
LONGITUDINAL DIRECTION
ONE SIDE
OTHER SIDE
WIDTHWISE DIRECTION
ONE SIDE

FIG. 3A

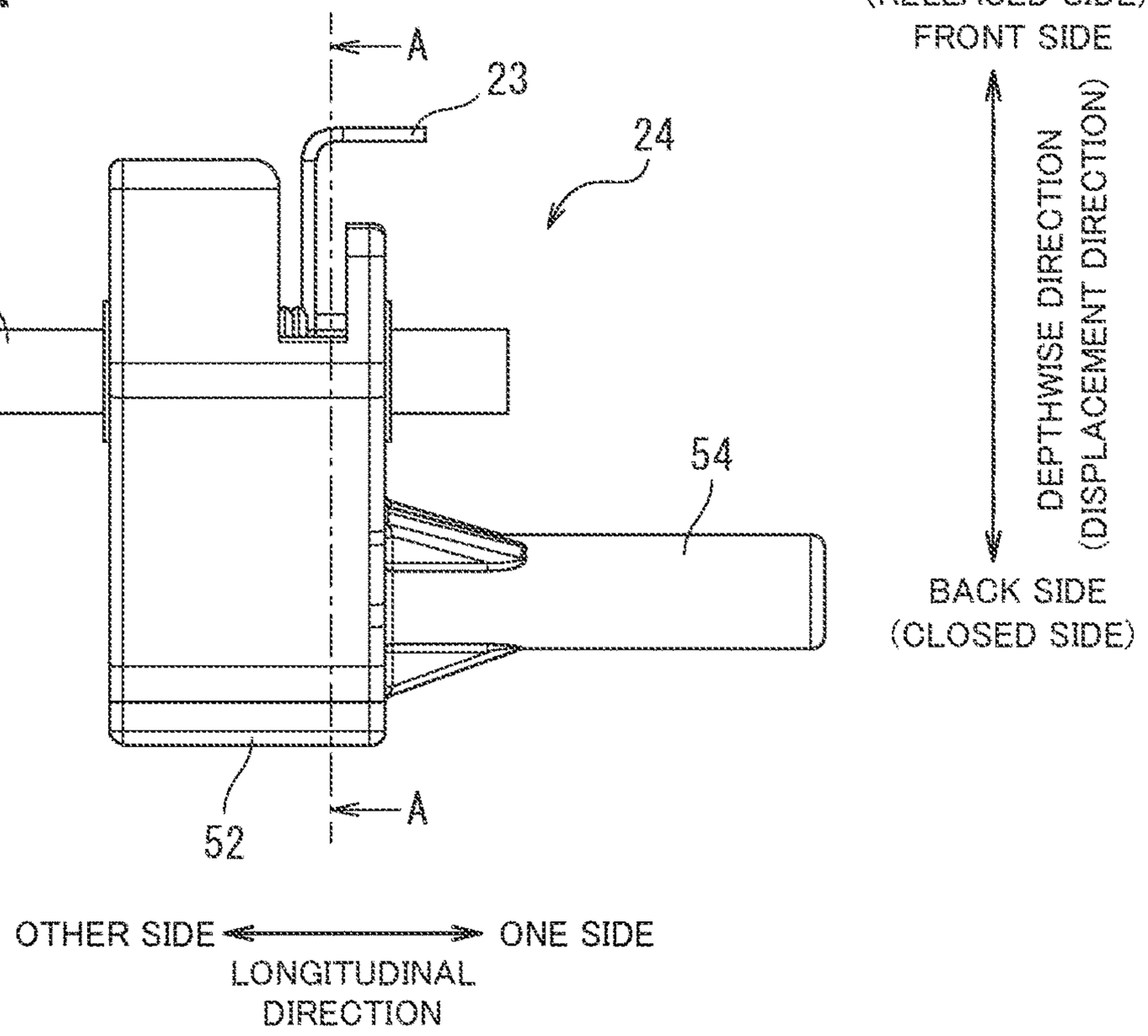

A
23
24
53
54
52
A
(RELEASED SIDE)
FRONT SIDE
DEPTHWISE DIRECTION
(DISPLACEMENT DIRECTION)
BACK SIDE
(CLOSED SIDE)
OTHER SIDE
ONE SIDE
LONGITUDINAL
DIRECTION

FIG. 3B

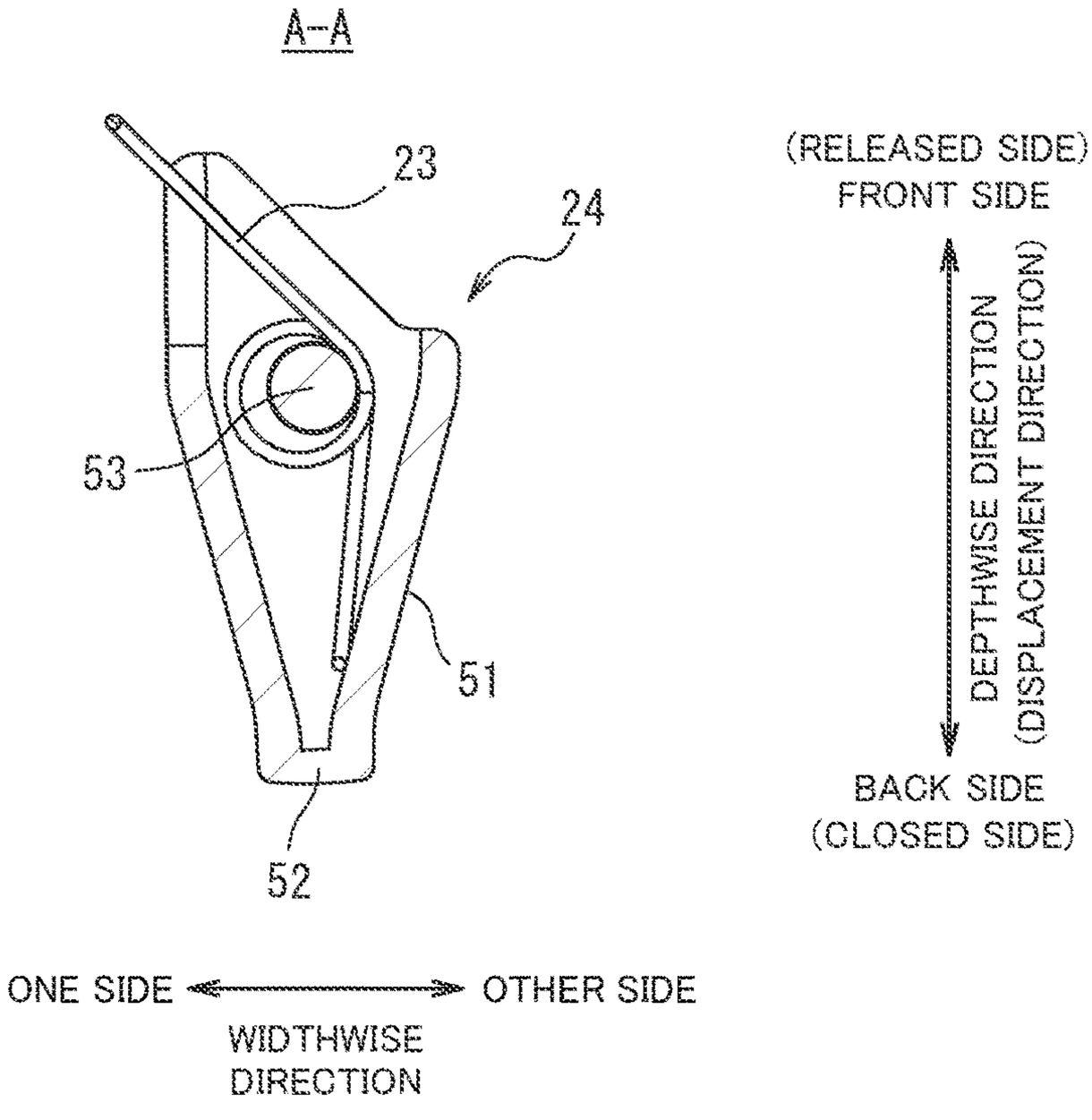

A-A
23
24
53
51
52
(RELEASED SIDE)
FRONT SIDE
DEPTHWISE DIRECTION
(DISPLACEMENT DIRECTION)
BACK SIDE
(CLOSED SIDE)
ONE SIDE
OTHER SIDE
WIDTHWISE
DIRECTION

FIG. 4

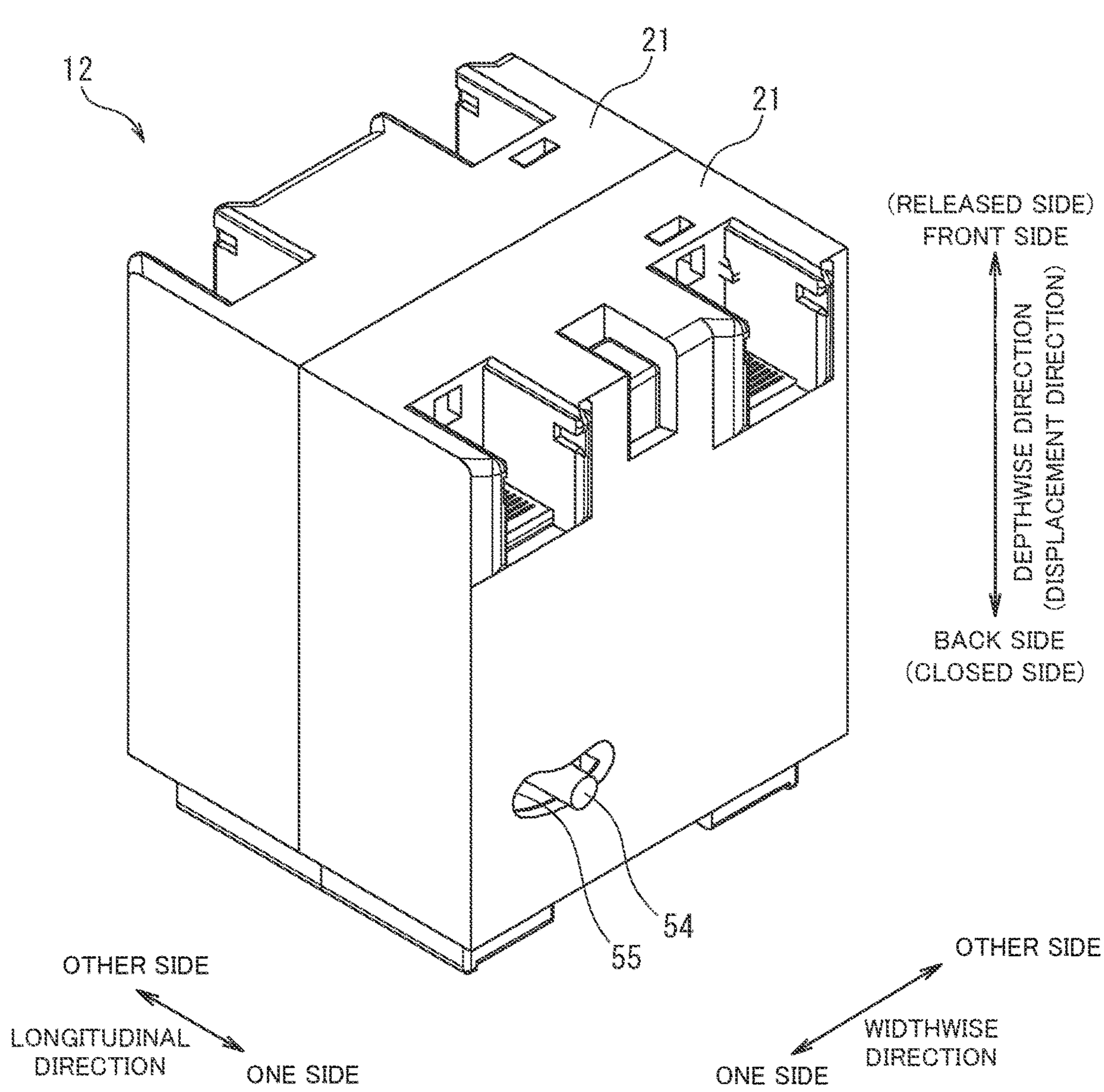

12
21
(RELEASED SIDE)
FRONT SIDE
DEPTHWISE DIRECTION
(DISPLACEMENT DIRECTION)
BACK SIDE
(CLOSED SIDE)
54
55
OTHER SIDE
LONGITUDINAL
DIRECTION
ONE SIDE
OTHER SIDE
WIDTHWISE
DIRECTION
ONE SIDE

FIG. 5A

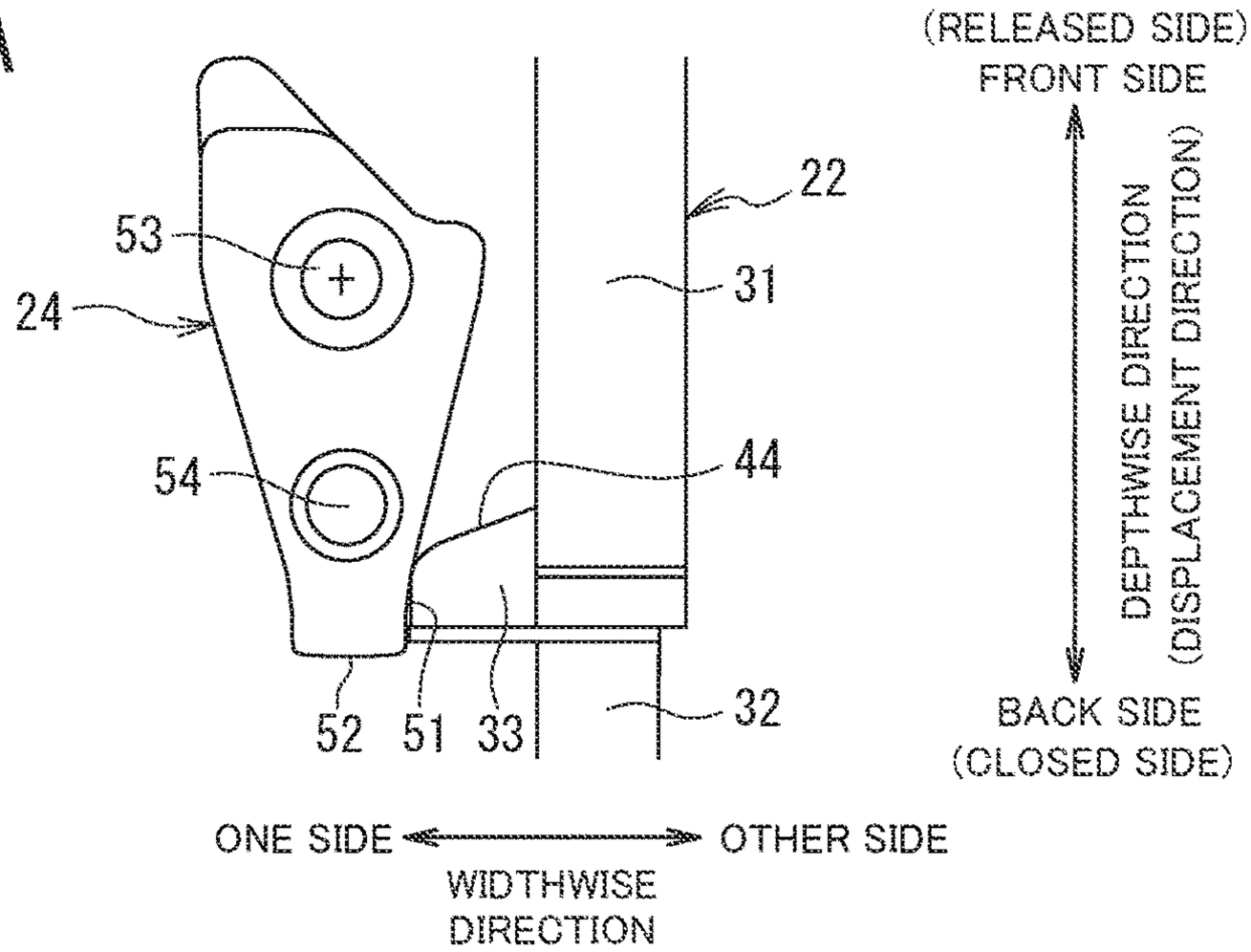


FIG. 5B

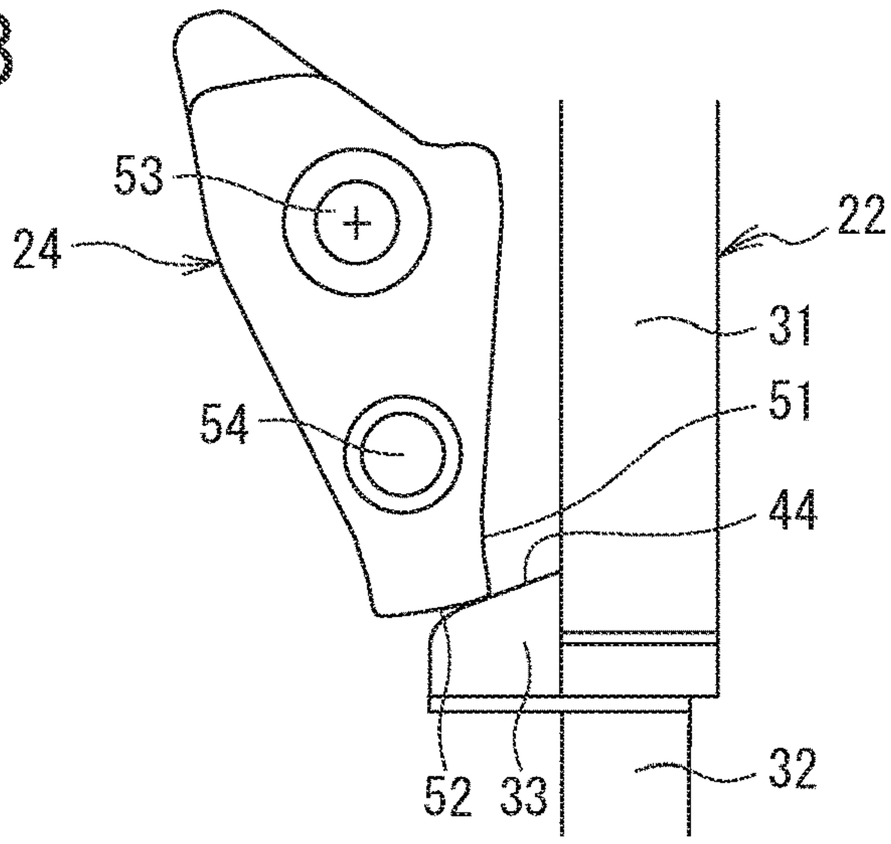


FIG. 5C

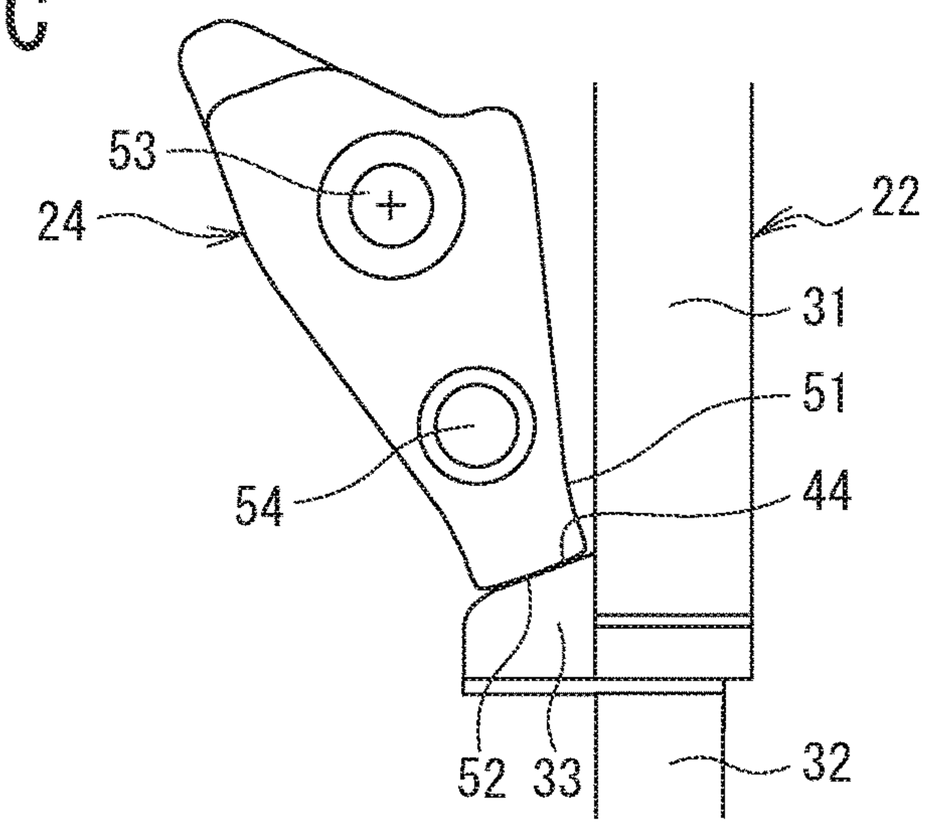


FIG. 6A

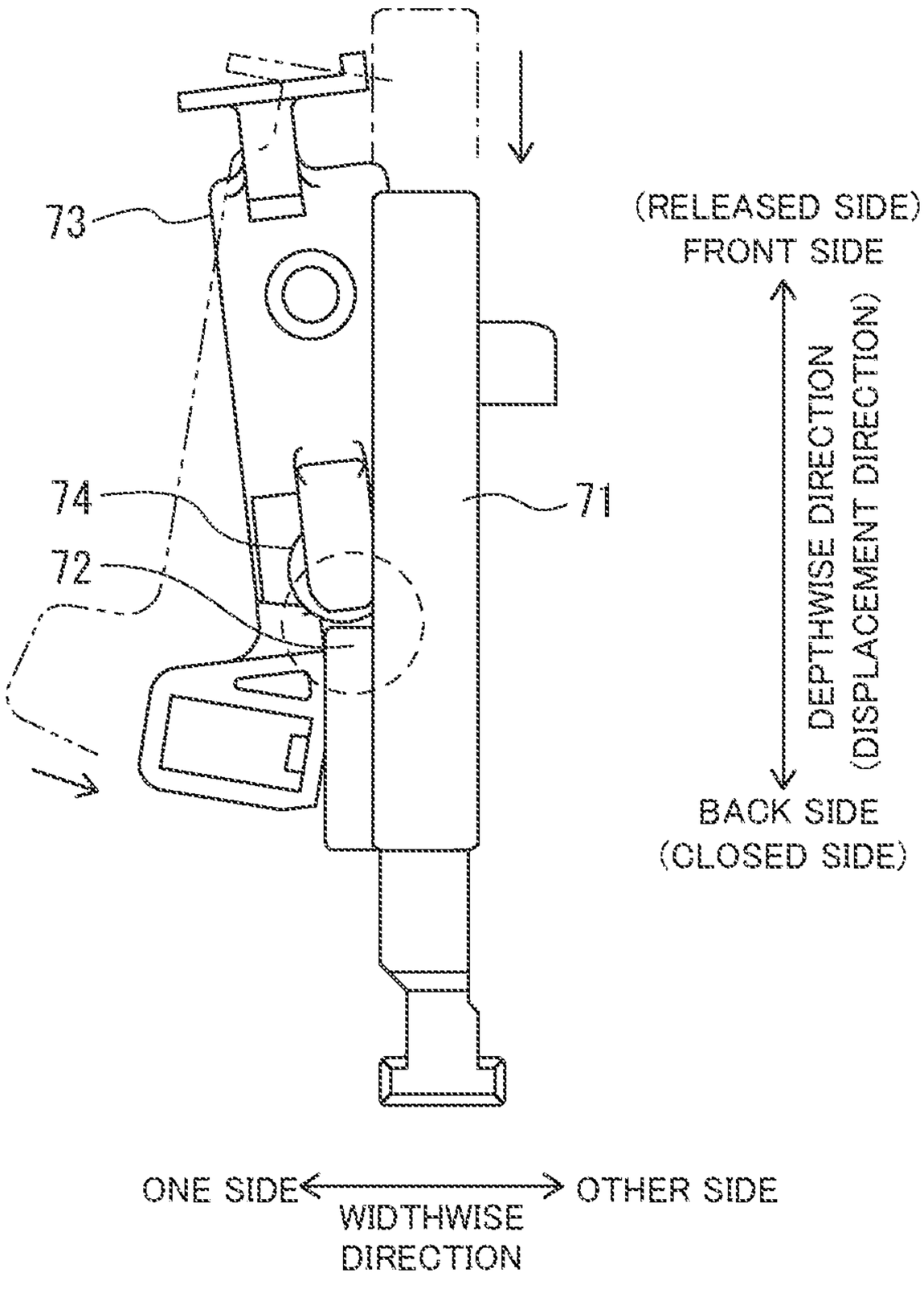

73
74
72
71
(RELEASED SIDE)
FRONT SIDE
DEPTHWISE DIRECTION
(DISPLACEMENT DIRECTION)
BACK SIDE
(CLOSED SIDE)
ONE SIDE
OTHER SIDE
WIDTHWISE
DIRECTION

FIG. 6B

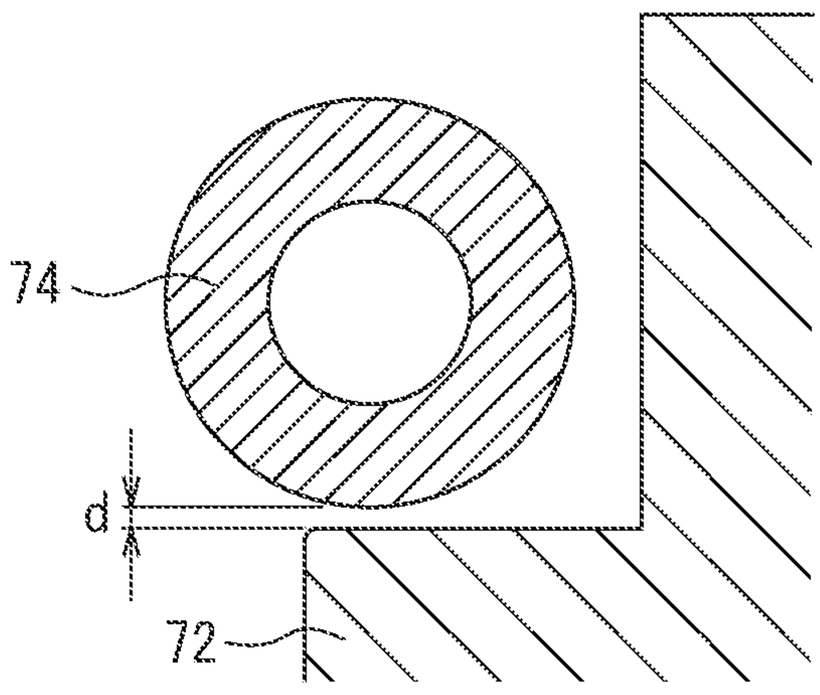

74
d
72

FIG. 7A

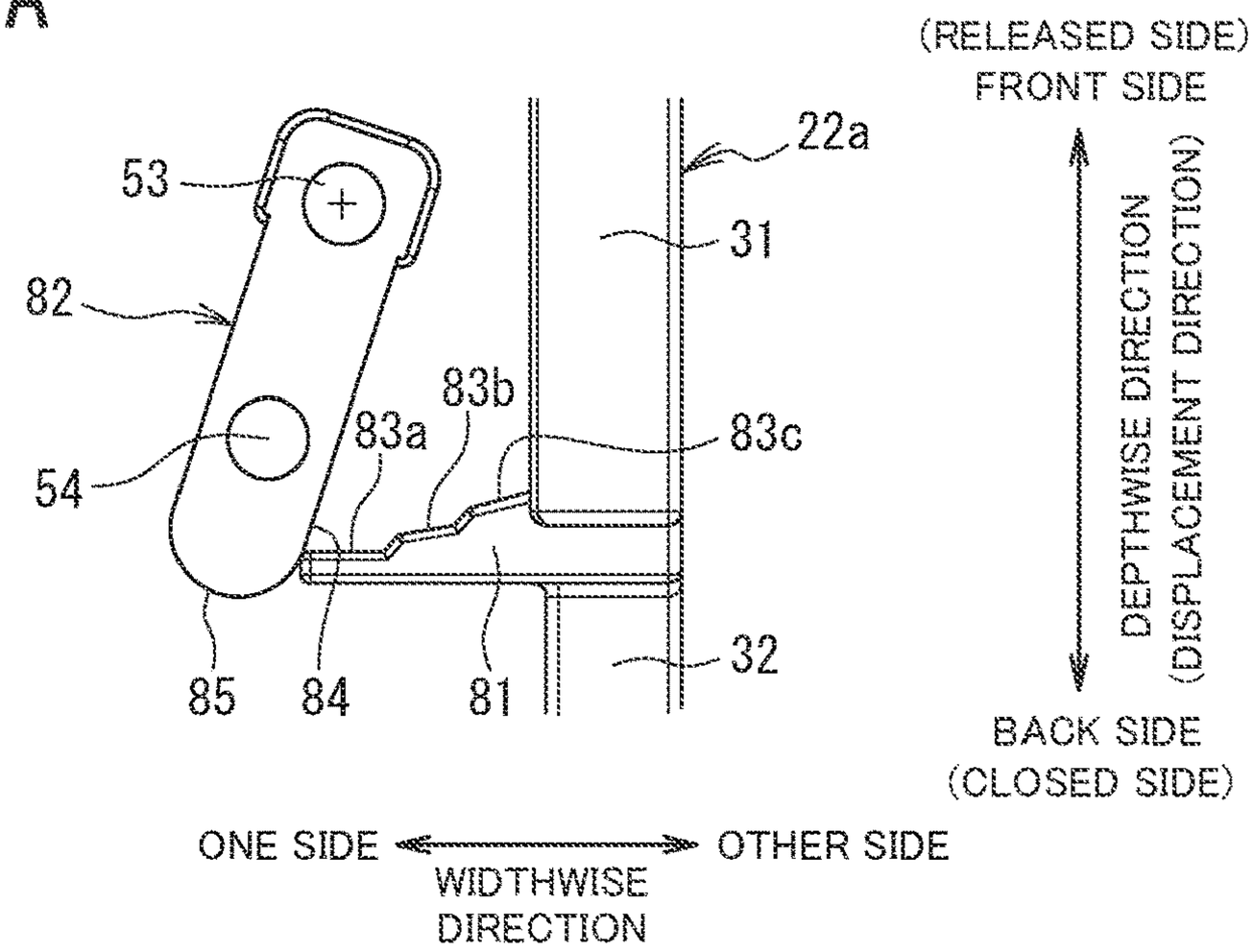


FIG. 7B

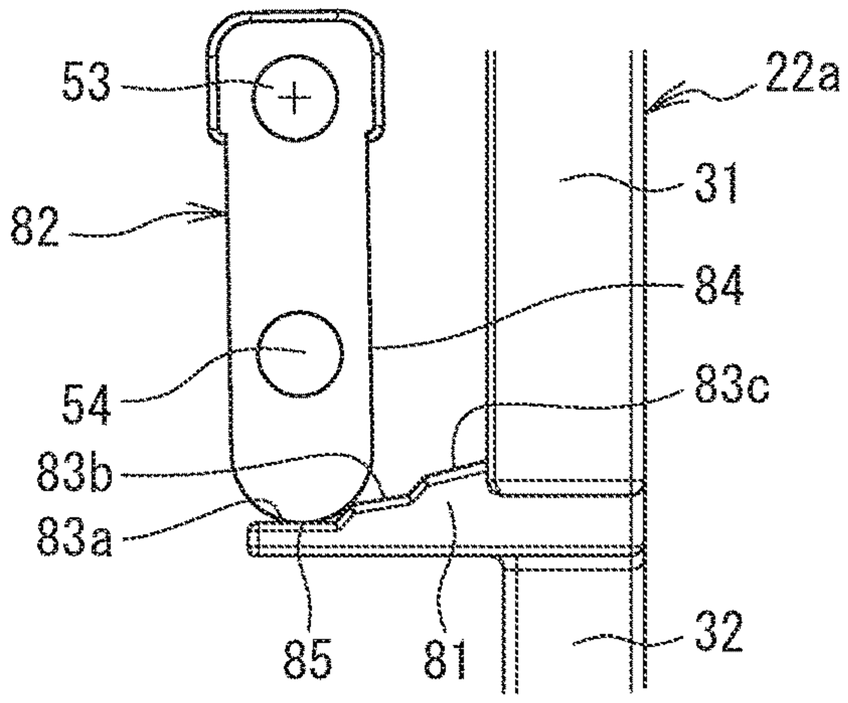
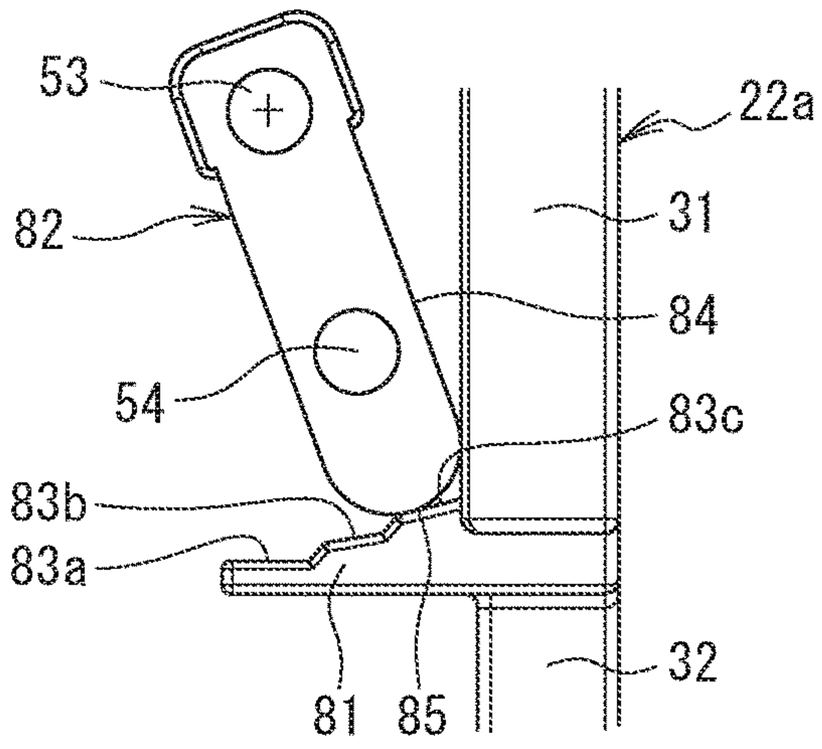


FIG. 7C



MECHANICAL LATCHING DEVICE OF ELECTROMAGNETIC CONTACTOR

CROSS REFERENCE TO RELATED APPLICATIONS AND INCORPORATION BY REFERENCE

This application claims benefit of priority under 35 USC 119 based on Japanese Patent Application No. 2021-111552 filed on Jul. 5, 2021, the entire contents of which are incorporated by reference herein.

TECHNICAL FIELD

The present invention relates to a mechanical latching device of an electromagnetic contactor.

BACKGROUND ART

When it is desired to prevent an electromagnetic contactor from being shut down due to a power failure or a dropped circuit voltage in a circuit or it is desired to suppress power consumption for energization at all times, the electromagnetic contactor is required to be mechanically held in a closed state. Therefore, a mechanical latching device is attached to the electromagnetic contactor. In a mechanical latching device disclosed in PTL 1, when a latch support is displaced to a closed side in conjunction with a contact support, a roller attached to a latch lever is caught on a shoulder portion of the latch support to mechanically prevent the latch support from returning to a released side.

CITATION LIST

Patent Literature

PTL 1: JP 2000-251601 A

SUMMARY OF INVENTION

Technical Problem

When a control coil of the electromagnetic contactor is excited, a slight gap (allowance) is provided between the shoulder portion of the latch support and the roller. However, the amount of stroke of the contact support varies depending on the model of the electromagnetic contactor and individual differences even in the same model, so that the gap also varies in size. When the excitation of the control coil of the electromagnetic contactor is stopped, the latch support returns by the amount of the gap, due to which depending on the size of the gap, there has been a need for gap adjustment work, such as replacement of the roller with one different in outer diameter.

An object of the present invention is to provide a mechanical latching device of an electromagnetic contactor that improves convenience by eliminating the need to adjust a gap between portions that mechanically prevent the returning of a latch support.

Solution to Problem

According to an aspect of the invention there is provided a mechanical latching device of an electromagnetic contactor, the mechanical latching device including: a latch support connected to a contact support of the electromagnetic contactor and displaceable between a released side and a closed side, the latch support including a protrusion protruding laterally and formed with a latch surface facing the released side; and a rotating member having one end side rotatably supported beside the latch support and an other end side biased toward the protrusion, wherein when the latch support is on the released side, an outer peripheral surface of the other end side is in contact with a tip of the protrusion to allow the latch support to be displaced to the closed side, and when the latch support is on the closed side, the other end side rotates according to a position of the latch support in a displacement direction, and a tip surface of the other end side faces the latch surface to mechanically prevent the latch support from returning to the released side at a plurality of positions along the displacement direction.

Advantageous Effects of Invention

According to the present invention, when the latch support is on the closed side, the tip surface of the rotating member faces the latch surface according to the position of the latch support in the displacement direction, thereby mechanically preventing the latch support from returning to the released side at the plurality of positions along the displacement direction. This eliminates the need for work on adjusting the gap between the portions that mechanically prevent the returning of the latch support, so that improved convenience can be achieved.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a diagram illustrating a mechanical latching device of an electromagnetic contactor;

FIG. **2** is a diagram illustrating a latch support;

FIGS. **3**A and **3**B are diagrams illustrating a rotating member;

FIG. **4** is a diagram illustrating an external appearance of a mechanical latching device **12**;

FIGS. **5**A to **5**C are diagrams illustrating an operation of the rotating member;

FIGS. **6**A and **6**B are diagrams illustrating a comparative example; and

FIGS. **7**A to **7**C are diagrams illustrating an operation of a rotating member.

DESCRIPTION OF EMBODIMENTS

Hereinafter, embodiments of the present invention are described with reference to the drawings. It should be noted that each drawing is schematic and may not be the same as actual one. Additionally, the embodiments given below exemplify devices and methods for embodying the technological concept of the present invention, and do not limit components of the invention to those below. In other words, various modifications can be added to the technological concept of the present invention without departing from the technological scope described in the appended claims.

First Embodiment

Configuration

In the following description, three directions orthogonal to each other are defined as longitudinal direction, widthwise direction, and depthwise direction for convenience. Note that a front side in the depthwise direction corresponds to a released side in a displacement direction, and a back side in the depthwise direction corresponds to a closed side in the displacement direction.

FIG. **1** is a diagram illustrating a mechanical latching device of an electromagnetic contactor.

When it is desired to prevent an electromagnetic contactor **11** from being shut down due to a power failure or a dropped circuit voltage in a circuit or it is desired to suppress power consumption for energization at all times, the electromagnetic contactor **11** is required to be mechanically kept in an closed state. To do so, a mechanical latching device **12** is attached to the electromagnetic contactor **11**. Here, apart of the electromagnetic contactor **11** is virtually indicated by a long dashed double-short dashed line, and a detailed description thereof is omitted.

The following is a description of the mechanical latching device **12**. Here is illustrated a structure of the mechanical latching device **12** as viewed from a longitudinal one side thereof, in which no illustration of a contact portion is given for ease of description. The mechanical latching device **12** includes a case **21**, a latch support **22**, a torsion spring **23**, a rotating member **24**, an electromagnet **25**, and a plunger **26**.

The case **21** has a substantially rectangular parallelepiped external shape and is attached on the front side of the depthwise direction in the electromagnetic contactor **11**.

The latch support **22** is arranged at substantially a center of the case **21** in the widthwise direction inside the case **21**. A portion of the latch support **22** on the back side in the depthwise direction is caused to protrude from an opening portion **13** of the case **21** and connected to a contact support **14** of the electromagnetic contactor **11**, thereby allowing the latch support **22** to be displaceable between the released side and the closed side. Here, apart of the contact support **14** is virtually indicated by a long dashed double-short dashed line, and a detailed description thereof is omitted.

FIG. **2** is a diagram illustrating the latch support **22**.

The latch support **22** includes a base body **31**, a leg portion **32**, a protrusion **33**, a b contact portion **34**, and an a contact portion **35**.

The base body **31** has a substantially plate shape along the displacement direction and the longitudinal direction. At substantially a center thereof in the longitudinal direction is formed a through hole **41** extending along the displacement direction and penetrating in the widthwise direction.

The leg portion **32** is provided on the closed side of the base body **31** and extends along the closed side. The leg portion **32** is formed with a recessed groove **42** formed along the longitudinal direction at an end thereof on the closed side. The recessed groove **42** has a portion on the released side extending to both sides in the widthwise direction and is formed into a substantially T shape as viewed from the longitudinal direction. When the recessed groove **42** is fitted into the contact support **14** of the electromagnetic contactor **11** along the longitudinal direction (see FIG. **1**), the latch support **22** is displaceable between the released side and the closed side in conjunction with the contact support **14**.

The protrusion **33** is formed on one side of the base body **31** in the widthwise direction and at a portion of the through hole **41** on the closed side. The protrusion **33** protrudes on the one side in the widthwise direction and includes a latch surface **44** facing the released side. The portion of the through hole **41** on the closed side reaches the protrusion **33**, and a part of the latch surface **44** is formed to be recessed toward the closed side. The latch surface **44** is inclined in such a manner as to go from the closed side to the released side from the rotating member **24** side toward the latch support **22** side. The inclination of the latch surface **44** is at an angle of, for example, around 20 degrees with respect to a plane along the longitudinal and widthwise directions. Preferably, the protrusion **33** has a tip chamfered so as to prevent burrs.

The b contact portion **34** has a substantially square cylindrical shape penetrating in the longitudinal direction, and is formed on the one side of the base body **31** in the widthwise direction and at a portion that is further on the released side than the through hole **41**. The b contact portion **34** elastically supports an unillustrated movable contact element. The b contact portion **34** causes the movable contact element to contact with an unillustrated fixed contact element when the latch support **22** is on the released side, and separates the movable contact element from the fixed contact element when the latch support **22** is on the closed side.

The a contact portion **35** has a substantially square cylindrical shape penetrating in the widthwise direction, and is formed on an other side of the base body **31** in the widthwise direction and at a portion that is further on the released side than the through hole **41**. The a contact portion **35** elastically supports an unillustrated movable contact element. The a-contact portion **35** separates the movable contact element from an unillustrated fixed contact element when the latch support **22** is on the released side, and causes the movable contact element to contact with the fixed contact element when the latch support **22** is on the closed side.

FIGS. **3**A and **3**B are diagrams illustrating the rotating member **24**.

FIG. **3**A is a diagram of the rotating member **24** as viewed from outside in the longitudinal direction, and FIG. **3**B is a cross sectional diagram thereof taken along line A-A as viewed from one side in the widthwise direction. The rotating member **24** is larger than the through hole **41** of the latch support **22** in the longitudinal direction. Additionally, the rotating member **24** has a hollow inside, and a portion of the rotating member **24** on a front side in the depthwise direction widened in the widthwise direction is open, whereas a portion thereof on a back side in the depthwise direction narrowed in the widthwise direction is closed, thereby forming a substantially V-shaped cross section along the widthwise and depthwise directions as viewed from the longitudinal direction. The portion of the rotating member **24** on the back side in the depthwise direction is formed with an outer peripheral surface **51** facing the protrusion **33** of the latch support **22** and a substantially flat tip surface **52** facing the back side in the depthwise direction. The portion of the rotating member **24** on the front side in the depthwise direction includes a cylindrical support shaft **53** along the longitudinal direction being inserted through the portion, and the rotating member **24** is supported on the case **21** in a rotatable manner by the support shaft **53**. Inside the rotating member **24**, the support shaft **53** is inserted through the torsion spring **23**. One end side of the torsion spring **23** is in contact with an inner peripheral surface of the case **21**, and an other end side thereof is in contact with an inner peripheral surface of the rotating member **24**, thereby biasing the portion of the rotating member **24** on the back side in the depthwise direction toward the protrusion **33** (see FIG. **1**).

On the outer peripheral surface **51** of the rotating member **24** is formed a cylindrical manual operation portion **54** protruding on one side in the longitudinal direction.

FIG. **4** illustrates an external appearance of the mechanical latching device **12**.

One side surface of the case **21** in the longitudinal direction is formed with a long hole **55** that exposes the

manual operation portion **54**. The manual operation portion **54** is set to be long enough to stick out slightly from the side surface of the case **21**. The long hole **55** extends in an arc shape along a trajectory of the manual operation portion **54** when the rotating member **24** rotates.

As illustrated in FIG. **1**, the electromagnet **25** is arranged on the other side in the widthwise direction of the latch support **22** inside the case **21**. Here, the electromagnet **25** is virtually indicated by a long dashed double-short dashed line, and a detailed description thereof is omitted, but includes a spool, a control coil, a yoke, and a return spring, all of which are not illustrated. Then, when the control coil is energized and excited, the plunger **26** is moved forward to the one side in the widthwise direction against an elastic force of the return spring. When the energization of the control coil is stopped to bring the control coil into an unexcited state, the return spring moves the plunger **26** backward to the other side in the widthwise direction.

The plunger **26** is a yoke inserted into the spool of the electromagnet **25**, and is formed with a cylindrical protrusion rod **28** protruding on the one side in the widthwise direction. The protrusion rod **28** penetrates through the insertion hole **41** of the latch support **22** to the one side in the widthwise direction and has a hemispherical tip facing the rotating member **24**.

Operation

Next is a description of a main operation of the first embodiment.

FIGS. **5**A to **5**C are diagrams illustrating an operation of the rotating member **24**.

FIG. **5**A illustrates a state where the rotating member **24** is in an initial position. Here, the latch support **22** is on the released side in conjunction with the contact support **14**, and the outer peripheral surface **51** of the rotating member **24** is in contact with the tip of the protrusion **33** of the latch support **22**. In other words, the rotating member **24** is in the initial position where the portion thereof on the back side in the depthwise direction is displaced to the one side in the widthwise direction against an elastic force of the torsion spring **23**. In this case, the latch support **22** is allowed to be displaced to the closed side.

FIG. **5**B illustrates a state where the rotating member **24** has rotated from the initial position. Here, the latch support **22** is on the closed side in conjunction with the contact support **14**, and the rotating member **24** is rotated by the elastic force of the torsion spring **23**, as a result of which the portion of the rotating member **24** on the back side in the depthwise direction is displaced to the other side in the widthwise direction. In this case, the tip surface **52** of the rotating member **24** contacts with the latch surface **44** of the protrusion **33** to mechanically prevent the latch support **22** from returning to the released side.

FIG. **5**C illustrates a state where the rotating member **24** has further rotated from the initial position. Here, the latch support **22** is further on the closed side than in the state of FIG. **5**B in conjunction with the contact support **14**, and the rotating member **24** is rotated by the elastic force of the torsion spring **23**, as a result of which the portion of the rotating member **24** on the back side in the depthwise direction is further displaced to the other side in the widthwise direction than in the state of FIG. **5**B. In this case, the tip surface **52** of the rotating member **24** contacts with the latch surface **44** of the protrusion **33** to mechanically prevent the latch support **22** from returning to the released side.

Next, a description is given of how to cancel the latched state mechanically preventing the latch support **22** from returning to the released side. One way is to drive the plunger **26**. Specifically, when the plunger **26** is moved forward to the one side in the widthwise direction by the electromagnet **25** in the closed state, the protrusion rod **28** pushes the rotating member **24** to displace the portion of the rotating member **24** on the back side in the depthwise direction to the one side in the widthwise direction. Another way is to manually operate the manual operation portion **54**. Specifically, when a user operates the manual operation portion **54** of the rotating member **24** in the closed state, the portion of the rotating member **24** on the back side in the depthwise direction is displaced to the one side in the widthwise direction. In this way, returning the rotating member **24** to the initial position allows for cancellation of the latched state of the latch support **22**.

Effects

Next, main effects of the first embodiment are described.

The amount of stroke of the contact support **14** varies depending on the model of the electromagnetic contactor **11**, due to which the conventional structure has required the adjustment of the gap between the portions that mechanically prevents the returning of the latch support.

Thus, the mechanical latching device **12** of the electromagnetic contactor **11** according to the first embodiment includes the latch support **22** and the rotating member **24**. The latch support **22** is connected to the contact support **14** of the electromagnetic contactor **11** and displaceable between the released side and the closed side. The latch support **22** includes the protrusion **33** protruding laterally and formed with the latch surface **44** facing the released side. One end side of the rotating member **24** is rotatably supported beside the latch support **22**, and the other end side thereof is biased toward the protrusion **33**. Additionally, when the latch support **22** is on the released side, the outer peripheral surface **51** on the other end side of the rotating member **24** contacts with the tip of the protrusion **33**, allowing the latch support **22** to be displaced to the closed side. In addition, when the latch support **22** is on the closed side, the other end side of the rotating member **24** rotates according to the position of the latch support **22** in the displacement direction, and the tip surface **52** faces the latch surface **44**, thereby mechanically preventing the latch support **22** from returning to the released side at the plurality of positions along the displacement direction. This eliminates the need for work on adjusting a gap between the portions that mechanically prevent the returning of the latch support **22**, so that improved convenience can be achieved. Furthermore, the rotating member **24** is a single component, enabling suppression of increase in the number of components, and also facilitating assembly.

The latch surface **44** is inclined in such a manner as to go from the closed side to the released side from the rotating member **24** side toward the latch support **22** side. As a result, the tip surface **52** of the rotating member **24** faces the latch surface **44** according to the position of the latch support **22**, thereby enabling the latch support **22** to be mechanically prevented from returning to the released side at the plurality of positions along the displacement direction. Moreover, any gap can be eliminated between the portions mechanically preventing the returning of the latch support **22**. Accordingly, even when the control coil of the electromagnetic contactor **11** is not excited, the returning of the latch support **22** can be suppressed. In addition, in such a cam structure that the rotating member **24** is driven so as to follow a contour of the latch surface **44**, the rotating member **24** can be operated smoothly without any sense of stepping since

the latch surface **44** has no steps. Furthermore, the latch surface **44** of the protrusion **33** and the tip surface **52** of the rotating member **24** are not required to have high accuracy in dimensions, so that increased manufacturing cost can be suppressed.

The mechanical latching device **12** includes the plunger **26**. The plunger **26** is driven by the electromagnet **25**. When the plunger **26** moves forward from the latch support **22** side toward the outer peripheral surface **51** on the other end side of the rotating member **24**, the tip of the plunger **26** pushes back the outer peripheral surface **51** on the other end side of the rotating member **24**. This can easily cancel the latched state of the latch support **22**.

The rotating member **24** includes the manual operation portion **54** that is rotatably operated by a user. Accordingly, when the manual operation portion **54** of the rotating member **24** is operated by the user, the portion thereof on the back side in the depthwise direction is pushed back. This allows for easy cancellation of the latched state of the latch support **22**.

Next, a comparative example is described.

FIGS. **6**A and **6**B are diagrams illustrating the comparative example.

FIG. **6**A is a diagram of the comparative example as viewed from one side in the longitudinal direction. In the drawing, a latch support **71** includes a shoulder portion **72**, and a latch lever **73** includes a roller **74**. In the comparative example, when the latch support **71** is displaced to the closed side, the roller **74** of the latch lever **73** is caught on the shoulder portion **72** of the latch support **71** to mechanically prevent the latch support **71** from returning to the released side. FIG. **6**B is an enlarged diagram of the portions mechanically preventing the returning of the latch support **71**. Excitation of the control coil of the electromagnetic contactor **11** provides a slight gap "d" (allowance) between the shoulder portion **72** and the roller **74**. However, the amount of stroke of the contact support **14** varies depending on the model of the electromagnetic contactor **11**, due to which the gap "d" also varies in size. When the control coil of the electromagnetic contactor **11** goes into an unexcited state, the latch support **71** returns by the size of the gap "d". Therefore, depending on the size of the gap "d", there is a need for work on adjusting the gap "d", such as replacement with the roller **74** that has a different outer diameter.

Second Embodiment

Configuration

The second embodiment has the same configuration as the first embodiment described above, except that the portions that mechanically prevent the returning of the latch support **22** are changed in structure. Therefore, the common components are denoted by the same reference signs, and a detailed description thereof is omitted.

FIGS. **7**A to **7**C are diagrams illustrating an operation of the rotating member **82**.

Here, the latch support **22**, the protrusion **33**, and the rotating member **24** described above are newly changed to a latch support **22***a*, a protrusion **81**, and a rotating member **82**.

Latch surfaces **83***a* to **83***c* of the protrusion **81** are formed into a stepped shape in such a manner as to go from the closed side to the released side from the rotating member **82** side toward the latch support **22***a* side. Here, the positions of the latch surfaces **83***a* to **83***c* in the displacement direction are set to go up to the released side in an order of the latch surface **83***a*, the latch surface **83***b*, and the latch surface **83***c* from one side toward the other side in the widthwise direction. The latch surface **83***a* is a plane along the longitudinal and widthwise directions, whereas the latch surfaces **83***b* and **83***c* are slightly inclined in such a manner as to go from the closed side to the released side from the rotating member **82** side toward the latch support **22***a* side. Each step has the same height, which is, for example, approximately 0.5 mm.

The rotating member **82** extends in the depthwise direction. A portion of the rotating member **82** on the back side in the depthwise direction is formed with an outer peripheral surface **84** facing the protrusion **81** of the latch support **22***a* and a tip surface **85** having a semicircular shape as viewed from the longitudinal direction and facing the back side in the depthwise direction. Note that as in the first embodiment described above, the rotating member **82** is rotatably supported by the support shaft **53**, the cylindrical manual operation portion **54** is formed, and the portion of the rotating member **82** on the back side in the depthwise direction is biased by the torsion spring **23** toward the protrusion **81**.

Operation

Next, a main operation of the second embodiment is described.

FIG. **7**A illustrates a state where the rotating member **82** is in an initial position. Here, the latch support **22***a* is on the released side in conjunction with the contact support **14**, and the outer peripheral surface **84** of the rotating member **82** is in contact with the tip of the protrusion **81** of the latch support **22***a*. In other words, the rotating member **82** is in the initial position where the portion thereof on the back side in the depthwise direction is displaced to one side in the widthwise direction against the elastic force of the torsion spring **23**. In this case, the latch support **22***a* is allowed to be displaced to the closed side.

FIG. **7**B illustrates a state where the rotating member **82** has rotated from the initial position. Here, the latch support **22***a* is on the closed side in conjunction with the contact support **14**, and the rotating member **82** is rotated by the elastic force of the torsion spring **23**, as a result of which the portion of the rotating member **82** on the back side in the depthwise direction is displaced to the other side in the widthwise direction. In this case, the tip surface **85** of the rotating member **82** contacts with the latch surface **83***a* of a first step of the protrusion **81** to mechanically prevent the latch support **22***a* from returning to the released side.

FIG. **7**C illustrates a state where the rotating member **82** has further rotated from the initial position. Here, the latch support **22***a* is further on the closed side than in the state of FIG. **7**B in conjunction with the contact support **14**, and the rotating member **82** is rotated by the elastic force of the torsion spring **23**, as a result of which the portion of the rotating member **82** on the back side in the depthwise direction is further displaced to the other side in the widthwise direction than in the state of FIG. **7**B. In this case, the tip surface **85** of the rotating member **82** contacts with the latch surface **83***c* of a third step of the protrusion **81** to mechanically prevent the latch support **22***a* from returning to the released side.

Other operations are the same as those of the first embodiment described above.

Effects

Next, main effects of the second embodiment are described.

The mechanical latching device **12** of the electromagnetic contactor **11** according to the second embodiment includes the latch support **22***a* and the rotating member **82**. The latch support **22***a* is connected to the contact support **14** of the electromagnetic contactor **11** and displaceable between the released side and the closed side. The latch support **22***a* includes the protrusion **81** protruding laterally and formed with the latch surfaces **83***a* to **83***c* facing the released side. One end side of the rotating member **82** is rotatably supported beside the latch support **22***a*, and the other end side thereof is biased toward the protrusion **81**. Additionally, when the latch support **22***a* is on the released side, the outer peripheral surface **84** on the other end side of the rotating member **82** contacts with the tip of the protrusion **81**, allowing the latch support **22***a* to be displaced to the closed side. In addition, when the latch support **22***a* is on the closed side, the other end side of the rotating member **82** rotates according to the position of the latch support **22***a* in the displacement direction, and the tip surface **85** faces the latch surfaces **83***a* to **83***c*, thereby mechanically preventing the latch support **22***a* from returning to the released side at the plurality of positions along the displacement direction. This eliminates the need for work on adjusting the gap between the portions mechanically preventing the returning of the latch support **22***a*, so that improved convenience can be achieved. Furthermore, the rotating member **82** is a single component, enabling suppression of increase in the number of components, and also facilitating assembly.

The latch surfaces **83***a* to **83***c* are formed into the stepped shape in such a manner as to go from the closed side to the released side from the rotating member **82** side toward the latch support **22***a* side. As a result, the tip surface **85** of the rotating member **82** faces any one of the latch surfaces **83***a* to **83***c* according to the position of the latch support **22***a*, thereby enabling the latch support **22***a* to be mechanically prevented from returning to the released side at the plurality of positions along the displacement direction. Additionally, in such a cam structure that the rotating member **82** is driven so as to follow the contours of the latch surfaces **83***a* to **83***c*, the rotating member **82** can be operated with a sense of moderation since the latch surfaces **83***a* to **83***c* are formed into the stepped shape.

Other effects are the same as those of the first embodiment described above.

Modifications

The second embodiment has been described using the configuration mechanically preventing the latch support **22***a* from returning to the released side at the three positions along the displacement direction. However, the present invention is not limited thereto. Thus, by changing the quantity of the latch surfaces, the latch support **22***a* may be mechanically prevented from returning to the released side at two positions or four or more positions along the displacement direction.

While the present invention has been described with reference to the limited number of embodiments, the scope of the rights of the invention is not limited thereto. It will be obvious to those skilled in the art that various changes and modifications may be made in the embodiments based on the above disclosure.

REFERENCE SIGNS LIST

11: Electromagnetic contactor
12: Mechanical latching device
13: Opening portion
14: Contact support
21: Case
22: Latch support
23: Torsion spring
24: Rotating member
25: Electromagnet
26: Plunger
28: Protrusion rod
31: Base body
32: Leg portion
33: Protrusion
34: b contact portion
35: a contact portion
41: Through hole
42: Recessed groove
44: Latch surface
51: Outer peripheral surface
52: Tip surface
53: Support shaft
54: Manual operation portion
55: Long hole
71: Latch support
72: Shoulder portion
73: Latch lever
74: Roller
22*a*: Latch support
81: Protrusion
82: Rotating member
83*a*: Latch surface
83*b*: Latch surface
83*c*: Latch surface
84: Outer peripheral surface
85: Tip surface
d: Gap

The invention claimed is:

1. A mechanical latching device of an electromagnetic contactor, the mechanical latching device comprising:

a latch support connected to a contact support of the electromagnetic contactor and displaceable between a released side and a closed side, the latch support including a protrusion protruding laterally and formed with a latch surface facing the released side; and

a rotating member having an end side rotatably supported beside the latch support and an other end side biased toward the protrusion,

wherein when the latch support is on the released side, an outer peripheral surface of the other end side of the rotating member is in contact with a tip of the protrusion to allow the latch support to be displaced to the closed side, and when the latch support is displaced to the closed side, the other end side of the rotating member is rotatable according to a position of the latch support in a displacement direction, from among a plurality of positions along the displacement direction, and a tip surface of the other end side of the rotating member faces the latch surface to mechanically prevent the latch support from returning to the released side.

2. The mechanical latching device of an electromagnetic contactor according to claim **1**, wherein the latch surface is inclined in such a manner as to go from the closed side to the released side from the rotating member side toward the latch support side.

3. The mechanical latching device of an electromagnetic contactor according to claim **1**, wherein the latch surface is formed into a stepped shape in such a manner as to go from

the closed side to the released side from the rotating member side toward the latch support side.

4. The mechanical latching device of an electromagnetic contactor according to claim **1**, further comprising a plunger configured to be driven by an electromagnet, the plunger pushing back the outer peripheral surface of the other end side of the rotating member at a tip of the plunger when moving forward from the latch support side toward the outer peripheral surface of the other end side of the rotating member.

5. The mechanical latching device of an electromagnetic contactor according to claim **1**, wherein the rotating member includes a manual operation portion configured to manually rotate the rotating member.

6. The mechanical latching device of an electromagnetic contactor according to claim **2**, further comprising a plunger configured to be driven by an electromagnet, the plunger pushing back the outer peripheral surface of the other end side of the rotating member at a tip of the plunger when moving forward from the latch support side toward the outer peripheral surface of the other end side of the rotating member.

7. The mechanical latching device of an electromagnetic contactor according to claim **3**, further comprising a plunger configured to be driven by an electromagnet, the plunger pushing back the outer peripheral surface of the other end side of the rotating member at a tip of the plunger when moving forward from the latch support side toward the outer peripheral surface of the other end side of the rotating member.

8. The mechanical latching device of an electromagnetic contactor according to claim **2**, wherein the rotating member includes a manual operation portion configured to manually rotate the rotating member.

9. The mechanical latching device of an electromagnetic contactor according to claim **3**, wherein the rotating member includes a manual operation portion configured to manually rotate the rotating member.

10. The mechanical latching device of an electromagnetic contactor according to claim **4**, wherein the rotating member includes a manual operation portion configured to manually rotate the rotating member.

11. The mechanical latching device of an electromagnetic contactor according to claim **6**, wherein the rotating member includes a manual operation portion configured to manually rotate the rotating member.

12. The mechanical latching device of an electromagnetic contactor according to claim **7**, wherein the rotating member includes a manual operation portion configured to manually rotate the rotating member.

* * * * *